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PHYSICAL CHEMISTRY.—*Adsorption and base exchange.*[1] P. G. NUTTING, Geological Survey.

One substance is adsorbed by another when it is not removable by a neutral solvent. Dyes are adsorbed by textile fibers, salts by soils, dark components of petroleum by filtering clays, so that they cannot be washed off by solvents, such as water, alcohol or gasoline. In a more general sense, a substance is adsorbed when its fugacity is lowered from what it would be were the second substance not present, its concentration increases and its vapor and solution tensions decrease as the adsorbing surface is approached. Adsorption is not necessarily limited to the visible surface and in some cases shades off into true chemical reaction in stoichiometric proportions or into true solution, long before molecular dimensions are reached.

Adsorption is naturally very sensitive to changes in temperature and pressure (or concentration) but reaches a true reversible equilibrium given time enough. In a few cases, a slight rise in temperature is sufficient to remove all or nearly all the moisture adsorbed on salts or minerals or the organic vapors adsorbed on charcoal. In comparatively few cases also, lowering the concentration (vapor or solution) may remove an adsorbed film. In general however adsorption-temperature and adsorption-concentration relations present the widest variety of forms and ranges.

The material adsorbed may be either molecular or ionic, positive ions depositing on an electronegative particle and vice versa. Polar molecules are adsorbed with like ends attached to the adsorbing surface, presenting a new adsorbing surface of the same charge as the

[1] Published by permission of the Director of the U. S. Geological Survey. Received December 11, 1930.

original one. Similarly positive and negative ions may pile up in alternate layers. In the case of adsorbed water, H and OH constitute the alternate layers and in thick films are indistinguishable from adsorbed molecular water. In crystallization from solution ions are adsorbed in pairs. Nonpolar molecules also vary in concentration near a surface of discontinuity but this is a purely physical phenomenon, the seat of surface tension and adhesion. This form of surface film yields readily to solvents and is not considered adsorption proper.

Base exchange is concerned with single layers of adsorbed ions, practically in chemical combination with the surface and in extreme cases, with every combinable atom present, whether the dispersion be partial or complete. It is not unusual to find one base completely replaceable while another is only partly replaceable in the same granular substance. Weak bases are replaced by stronger ones, and every other base by H by means of an acid treatment. The mass law holds and equilibrium constants may be found without great difficulty. Particles settling out carry adsorbed charges down with them. Table 1 shows the complexity of the behavior of even the simplest water suspensions.

Since two or more of these are usually present in any given sample of soil colloid, it is to be expected that conflicting results would be obtained in working with such samples.

Table 1 is somewhat idealized, for in water at room temperature the adsorption is probably many pairs of ions deep in all cases. However, the innermost layer is by far the most effective and dominates the behavior of the micelle. At higher temperatures, the outer less strongly held layers would be set free and this may account for the better results sometimes obtained at elevated temperatures in practical filtration, dyeing, etc.

Oil sands sometimes but rarely consist of well formed quartz crystals free from adsorbed coatings. Such sands usually consist of ill-formed, rough quartz grains, coated with ferrous or ferrous-aluminum silicates or with adsorbed black hydrocarbon which cannot be washed off with even the most powerful solvents. Grain coatings of carbonates (Fe, Ca, Mg) are not uncommon. The well known Bradford oil sand is coated first with colloidal iron, then with black hydrocarbon. The Tensleep oil sand is pure quartz heavily coated with a hydrocarbon. The pore walls of oil-bearing limes are black with hydrocarbon.

It is possible to peel off these two layers from a Bradford sand and even to restore them. The hydrocarbon is removed with chromic acid ("wet combustion"), the iron with ordinary acids. The grains thus peeled are active and if thoroughly washed and dried will readsorb coatings of either iron (from dialized iron in dilute suspension) or hydrocarbon from crude oil in a few hours. It was found easily possible to activate even sea sand or the faces of a quartz crystal by first attacking with alkali, then washing with acid, then with water, and drying. Such an activated silica surface, freed from H and OH by heating to 200°C., will freely adsorb all kinds of positive ions, even

TABLE 1. CLASSES OF WATER SUSPENSIONS

Class	Micelle	Surface	Exchangeable ion	Dispersing effect
1	Negative	H	H	Acid
2	Positive	OH	OH	Alkaline
3	Negative	OH inner H outer	H	Alkaline
4	Positive	H inner OH outer	OH	Acid

1. Silica gel, acid clay, humus.
2. Colloidal $Ca_3(PO_4)_2$, dialized iron (?).
3. Calcium permutites, zeolites, neg. $Al(OH)_3$.
4. Electropositive $Al(OH)_3$.

amphoteric colloidal alumina and probably anything less negative than silica.

Well-aged dialized iron is inert toward even strong acids or alkalis, but even a very dilute suspension (1 part per million) is readily adsorbed by active silica. Iron stains in old bath tubs are readily explained if it be supposed that the long-continued drip of fresh water on the porcelain leaches out sufficient alkali to leave an active alkali silicate surface to adsorb the very dilute iron from tap water. There is abundant geological evidence for the solution and redeposition of silica by water, hence it is not surprising to find oil sands generally activated and coated as well as silica cemented.

Classes 1 and 3 of Table 1 after thorough drying make good clarifying filters for mineral oils such as petroleum but do not filter vegetable

oils or mineral fats containing OH. If the normal hydrogen has been replaced by an alkali (K, Na), the filter must first be acid treated. On the other hand classes 2 and 4, or clays containing these in excess, make the best filters for animal and vegetable oils. That the presence of the hydroxyl ion is the vital factor is readily shown by adding a little alcohol, linseed oil or glycerine (all rich in OH) to a crude petroleum; filtration is inhibited.

One filtering clay is known which filters all three classes of oils about equally well. Chemical analysis shows this to contain a little alkali, enough to give it an amphoteric dispersing character; SiO_2 69, Al_2O_3 13, Fe_2O_3 3, (Ca, Mg)O 2, and $(K,Na)_2O$ 2.5 per cent, the rest chiefly water.

All good filtering clays retain 12 to 22 per cent of water when room-dry at low humidities and part with most of it only on heating to well over 150° or 200°C. This is as it should be with H and OH firmly adsorbed. Driving these off as water would leave open bonds ready to attack the more basic colored constituents of oil. If they be not driven off (moist filter), only bases stronger than H and OH and therefore capable of replacing them would be adsorbed and filtered out. It is found that a filter not thoroughly dried will filter black petroleum to a yellow but not to water white as a dry filter will.

Since adsorbed moisture leaves an active silicate surface only at high temperatures, a high-temperature (250°C.) water treatment is a means of producing an active surface on silica or a silicate. The H and OH bonds (toward silica) are in a labile state at such temperatures provided the water is confined to prevent its escape. Release of that pressure leaves the bonds open. Even a carbonate may be converted to a hydrate by high-temperature steam treatment if the CO_2 is allowed to escape while the supply of H_2O is maintained.

Many other colloidal oxides besides silica and the silicates may be prepared as good filters. Their action is similar in principle as regards adsorption and base exchange even when the micelle is electropositive. The writer has prepared three (Fe, Al and Si) so powerful as to crack even paraffin and heavy laxative oils, reducing them from clear to a black condition. This is done by preparing the gel in maximum dilution. Active colloidal iron, in the form of a dark red-brown powder, will even filter dialized iron from a very dilute yellow suspension, leaving clear water. This form of autoadsorption between colloids is akin to crystallization (adsorption of ions in pairs). The deposit of colloidal iron on and near the surface of siliceous pebbles in stream beds is very common.

ENTOMOLOGY.—*Two new hymenopterous parasites of* Tachypterellus consors *Dietz.*[1] A. B. GAHAN, U. S. Department of Agriculture, Bureau of Entomology. (Communicated by HAROLD MORRISON.)

Two species of Chalcidoidea which appear to be new to science are herewith described. These were reared by GEORGE M. LIST of the Colorado Agricultural College in connection with his studies of their host, a curculionid which is said to be causing considerable injury to cherries in the vicinity of Fort Collins, Colorado. Mr. LIST intends to describe the host insect as a new variety of *T. consors Dietz.*

Family PTEROMALIDAE

Habrocytus lividus, new species

This resembles *H. piercei* Crawford in size and shape but may be distinguished by the darker, less metallic color of the body and the dark brown or black tibiae, by the shorter ocellocular line which is barely longer than the diameter of an ocellus, and by the shorter propodeum which is without a distinct neck. Differs from *H. obscuripes* Ashmead by the differently colored body and legs, by the more strongly transverse head, and by the less strongly sculptured propodeum.

Female.—Length 2.6 mm. Antennae inserted at middle of head; scape cylindrical, extending a little above the vertex; pedicel about twice as long as broad, slender; two ring-joints distinct but transverse; first funicle joint about as long as and a little thicker than the pedicel, not quite twice as long as broad; second to fifth funicle joints each distinctly longer than broad, subequal in length to pedicel, the sixth barely longer than broad; club short ovate, one half wider than the sixth funicle joint and about as long as the fifth and sixth combined. Head strongly transverse, thin antero-posteriorly at vertex, concave behind, reticulate-punctate all over, the sculpture a little finer on vertex and cheeks than on frons and face; ocellocular line very slightly longer than the diameter of a lateral ocellus; eyes bare, malar space equal to about half the height of eye; right mandible four-toothed, the left three-toothed but with the inner tooth broadly truncate and a little concave at apex. Thorax sculptured like the head but with the punctures appearing a little deeper; mesoscutum broader than long, the parapsidal grooves absent on posterior half; scutellum and axillae a little more finely sculptured than the mesoscutum; propodeum short, with a median carina, the lateral folds more or less incomplete, represented at base by deep fossae on either side of the middle and at apex by similar fossae, the two fossae on each side sometimes joined to each other by a very weak longitudinal groove; spiracular groove deep and distinct, spiracles elliptical; propodeum medially with weak reticulation, usually with some foveae along the anterior margin, outside the folds practically smooth. Marginal vein of forewing twice as long as stigmal, the post-marginal very slightly shorter than marginal; discal cilia absent behind submarginal vein. Abdomen twice as long as thorax and about as wide as

[1] Received December 22, 1930.

thorax, conic ovate, sessile, the first tergite occupying less than one fourth the length of abdomen, smooth, following tergites weakly reticulated. General color bluish black; scape yellowish testaceous; flagellum dark brown; wings hyaline, venation pale brownish; coxae bluish, all femora and tibiae brownish black, the knees narrowly, extreme apices of hind tibiae and all tarsi yellowish testaceous; abdomen mostly black but with the basal tergite metallic blue green. The head, propodeum, underside of thorax, and the hind femora show strong steel-blue tints in some lights.

Male.—Length 2 mm. Similar to the female except that the antennal pedicel is hardly twice as long as thick, the club is very little broader than the preceding joint, the tibiae are brownish testaceous with the same color pattern as the female but not so dark, and the abdomen is not longer than the thorax.

Type-locality.—Fort Collins, Colorado.

Type.—Cat. No. 43263, U. S. N. M.

Host.—*Tachypterellus consors* Dietz.

Two females and five males received from G. M. List with the statement that they were reared from the above-named host infesting cherry. The type bears the date July 17, 1929, while other specimens bear dates ranging from July 13 to July 17, 1929. One male paratype was returned to the collector.

Family EULOPHIDAE

Entedon tachypterelli, new species

This species is similar to *E. occidentalis* Girault but differs by having the clypeus much smaller and less prominent, by having the post-marginal vein distinctly a little longer than the stigmal, and by having the abdomen distinctly conic-ovate and longer than the head and thorax combined. The first funicle joint is also shorter than in *E. occidentalis* and the hind tibiae are less extensively black.

Female.—Length 3 mm. Antennae inserted nearly on a line with the lower extremities of the eyes; consisting of eight joints and a very short terminal spine; scape cylindrical, slightly curved and attaining the level of the front ocellus; pedicel about two and one-half times as long as thick and somewhat more slender than first funicle joint; one small ring-joint; funicle three-jointed, the first joint a little more than two and one-half times as long as broad and slightly longer than the pedicel, second joint shorter than the first but longer than the third, the latter usually slightly less than twice as long as broad; club 2-jointed, about as long as first funicle joint, ovate and terminating in a very short spine.

Head viewed from above four times as broad as long; vertex perpendicularly truncated behind; occiput very slightly concave; eyes large, conspicuously hairy; ocelli in an obtuse triangle, the ocellocular line very slightly longer than the diameter of lateral ocellus; frontovertex strongly rugoso-punctate; face below antennae, cheeks, and temples more finely rugulose-punctate; clypeus not prominent, its anterior margin not reflexed. Thorax robust; prothorax short, much narrower and on a much lower level than the mesonotum; mesoscutum convex, coarsely rugoso-punctate, the punctures somewhat coarser on posterior half of the median lobe than elsewhere, the parapsidal

grooves complete and each terminating posteriorly in a deep depression; scutellum rather large, convex, sculptured like the mesoscutum, usually with a broad shallow transverse depression near the middle; axillae broadly separated and sculptured like the scutellum; propodeum shining, more or less weakly reticulated, the median carina distinct but without a foveolate furrow along either side of it, lateral folds represented by very broad deep furrows or depressions which cause that portion of the propodeum between these folds to appear as an elevated area with sharp lateral margins; propodeal spiracles round, the spiracular areas appearing as rather large tubercles or raised areas surrounded by deep grooves; marginal vein longer than submarginal and distinctly somewhat thicker at base than at apex; postmarginal longer than the stigmal; hind coxae dorsally rather coarsely reticulated, laterally and beneath more finely sculptured.

Abdomen conic-ovate, subsessile, about one-fourth longer than the head and thorax together, usually slightly narrower than the thorax, the first, second, third, and fourth tergites weakly reticulated; first, sixth, and seventh tergites subequal in length and each a little longer than any of the other tergites; ovipositor originating at or very near base of abdomen and not extending beyond the apex.

Head, thorax, all coxae, and first tergite bluish green, occiput black; antennal flagellum brownish black, the scape bluish green; mandibles black, with their apices brown; all trochanters, all femora, a band of varying width (sometimes embracing half their length) on the middle and hind tibiae near base, and the anterior and posterior margins of front tibiae, dark bluish to black; knees, all tibiae except as indicated, and all tarsi pale yellow; abdomen except first tergite bronzy black; wings hyaline with the venation dark brown.

Male.—Length 2.5 mm. Similar to the female but with the scape distinctly though not greatly thickened, the flagellum somewhat more tapered toward apex, the club more distinctly separated into two joints, the ocellocular line equal to the diameter of a lateral ocellus, abdomen not longer than the thorax, elliptical in outline, distinctly petiolate, the petiole about as long as broad. The color agrees with that of the female except that the front is deep purplish.

Type-locality.—Fort Collins, Colorado.

Type.—Cat. No. 43262, U. S. N. M.

Host.—*Tachypterellus consors* Dietz.

Described from eight females and eight males received from GEO. M. LIST of the Colorado Agricultural College with the information that they were reared from the above named curculionid. One paratype of each sex returned to the collector.

HERPETOLOGY.—*New Bahaman reptiles.*[1] DORIS M. COCHRAN, U. S. National Museum. (Communicated by C. WYTHE COOKE.)

During the summer of 1930 an extensive collecting trip through the Bahama Islands was carried out by Dr. PAUL BARTSCH of the United States National Museum, supported by the WALTER RATHBONE BACON Scholarship Fund. Islands which no naturalist had hitherto visited

[1] Received December 29, 1930. Published by permission of the Secretary of the Smithsonian Institution.

were explored for the first time scientifically. Excellent series of lizards obtained from many localities have already proved valuable in studies of variation among species which before have been poorly represented in any museum collection.

Leiocephalus inaguae, new species

Diagnosis.—A distinct lateral fold; four scales (an internasal and three prefrontals) between the rostral and the supraorbital ring; the second prefrontal large and in contact with its fellow; body scales moderately large, 70 to 82 dorsals between occiput and beginning of tail, 16 to 20 in the distance between end of snout and occiput; males with a row of large squarish black blotches on the shoulder region, continuing down the sides and fading out rapidly; faint traces of two more rows of squarish blotches on the back.

Type .—U. S. N. M. Cat. No. 81277, an adult male from Man of War Bay, Great Inagua Island, collected August 8, 1930.

Leiocephalus carinatus punctatus, new subspecies

Diagnosis.—Closely resembling the Cuban *Leiocephalus carinatus,* but differing from it in having a larger scale at the upper anterior region of the ear as well as in possessing a more vivid color pattern with a somewhat different arrangement of light and dark pigment especially on the head.

Type.—U. S. N. M. Cat. No. 81560 (collector's number 135), a male taken on the north shore of the bay at Jamaica Wells, Acklin Island, July 6, 1930.

Cyclura carinata bartschi new subspecies

Diagnosis.—Nasals broadly in contact with the rostral and with each other; a pair of supranasals also closely in contact with each other; the scales of the prefrontal region quite uniform in size and shape, and grading into the smaller frontal and parietal scales; supraorbital semicircles barely differentiated by an occasional somewhat enlarged scale; scales of the supraocular region distinctly smaller than the other supracephalic scutes; two to four enlarged vertical canthals on each side of the head; nuchal and caudal crests widely separated from the dorsal crest, which is 12 mm. high (in adult males) and is composed of 60 to 73 spines (average in 6 specimens, 63.5); nuchal crest composed of 16 to 20 spines (average 17.1), the highest of which measures 15 mm.; 4 vertical rows of small scales between the fifth and sixth verticils of the tail; 8 supralabials (rarely 9) to a point below the center of the eye; rostral wider than the mental; three to four enlarged tibial scales equaling the vertical diameter of the tympanic membrane.

Type.—U. S. N. M. Cat. No. 81212 (collector's number 172), an adult male from Booby Cay, east of Mariguana Island, Bahamas, collected July 21, 1930.

Anolis leucophaeus mariguanae, new subspecies

Diagnosis.—Similar to *Anolis leucophaeus* Garman, but differing from it in coloration. Ground color drab gray above, lavender-gray beneath, often with a wide clove-brown lateral band which originates on the loreal region, passes through the eye and above the ear, and widens above the shoulder continuing onto the base of the tail and gradually fading out; a light area usually bounding its lower border; a second dark lateral stripe beginning on the malar region just behind the mental, continuing back beneath the ear and

merging in front of the shoulder with the upper lateral stripe in some cases, in other cases widening and suffusing the entire side of the throat and upper-arm region with a dusky mottling; skin of gular fan lavender-gray, the scales white or olive-yellow. The young have dark latero-ventral reticulations, and the throat usually has a series of dark longitudinal lines. In adult males the tail fin is large and its upper edge is indistinctly mottled with dark in the region of the rays. Limbs sometimes unmarked, sometimes with wide, irregular dark bars. Scales on limbs a little smaller than in *leucophaeus* proper; scales of tail a little larger.

Type.—U. S. Nat. Mus. Cat. No. 81346, an adult male from Mariguana Cay, taken July 18, 1930.

ZOOLOGY.—*Flagellate spermatozoa in a nematode* (Trilobus longus).[1]

B. G. CHITWOOD, The George Washington University. (Communicated by PAUL BARTSCH.)

The spermatozoa of nematodes are usually thought of as ameboid, *Ascaris* having been the example studied for years. Yet Professor

Figure 1. Anterior end of a single sperm; from a section stained with dahlia and eosin.

Figure 2. A testis of a male *Trilobus longus* showing the flagellate spermatozoa. ×415.

E. B. WILSON in 1925[2] says "In others such as those of *Ascaris*, the sperm may be regarded as a much shortened and thickened flagelliform cell with a relatively large amount of cytoplasm and a very short and non-vibratile tail." If his conception is correct, one would expect to find among the free-living nematodes forms in which the spermatozoa retain their tail and are capable of movement.

While examining collections from the beach sand at White Lake, North Carolina, attention was drawn to the rather obvious spermatozoa of *Trilobus longus*. They may be readily seen in living specimens of both male and female. The spermatozoa (Fig. 1) are approximately 60μ long. The head is blunt and expanding quickly posteriorly, and of oval outline in transverse section. The small nucleus is situated

[1] Received November 6, 1930.

[2] *The cell in development and heredity*, p. 298.

at the extreme anterior end of the head. The tail is long and tapering. From a casual observation of both living and sectioned testes (Fig. 2), I am inclined to believe that spermatogenesis is normal. Primary and secondary spermatocytes as well as spermatids are present.

When a living specimen is mashed and the spermatozoa liberated on the slide they move with a slow serpentine motion. Spermatozoa thus freed are short-lived, lasting at best only about three minutes. In the female the activity of the spermatozoa is best observed. When mature females are examined, these almost always contain a somewhat twisted ball-shaped mass of spermatozoa in a definite place in each uterus, the spermatheca. Here they may be seen slowly squirming over one another.

Probably many other nematodes have flagellate spermatozoa. *Trilobus longus* is described by Dr. N. A. COBB in Ward and Whipple's *Fresh Water Biology*, a book available to most zoologists. The nematode is widespread, common on the sandy bottom of lakes and streams between the depths of six inches and two feet. The cytologist might find the spermatogenesis of *Trilobus* an interesting problem.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1004TH MEETING

The 1004th meeting was held in the Cosmos Club Auditorium, March 15, 1930, President LAMBERT presiding.

Program: W. J. ROONEY: *Earth-resistivity survey at Huancayo, Peru, and relation of resistivity to earth-current potential records.*—This survey, carried out near the Huancayo (Peru) Magnetic Observatory of the Department of Terrestrial Magnetism in the high Andes, is one of a series of earth-resistivity surveys made in connection with the study of earth-currents at observatories where potential gradient registration is in progress. The general resistivity of the region and its variation with position, depth, direction of current flow and rainfall, were determined. All may affect potential records and are indicative of the geological structure.

The resistivity of soil near the surface varied from over 100,000 to less than 2000 ohm-cm., depending on the character of the overburden. The mean values tended to converge to a value around 10,000 ohm-cm., as earth to depths of 200 to 300 meters was included in the measurements. These results are typical for an underlying structure of sedimentary rocks. A local area of high resistivity (values three times the mean for the region as a whole) was found near one earth-current line and explains the high-potential gradient records obtained from that line. The results were found to be independent of the orientation of the survey lines, indicating that the region is laterally isotropic. The seasonal variation was small and relatively unimportant. (*Author's abstract.*)

Discussed by Messrs. GISH and LAMBERT.

C. B. Watts: *The transit instrument and the synchronous motor.*—A new driving mechanism for the traveling-wire micrometer of a transit instrument has been developed at the Naval Observatory. It consists of a small synchronous motor, weighing only a few ounces, mounted on the micrometer and geared directly to the screw. The speed at which the traveling wire moves is adjusted to suit the declination of the star under observation by changing the frequency of the current which drives the motor.

A true alternating current is not required to run the motor, and it has been found convenient in practice to change a direct current by means of a rapidly revolving commutator into a rough approximation to a two-phase alternating current. The commutator is made to revolve at a speed corresponding to a particular declination by means of a friction drive. The observer can also cause the brushes which take the current from the commutator to rotate slowly in one direction or the other and thus alter the frequency by such amounts as are necessary to keep the star bisected. This auxiliary apparatus is controlled by means of a push button in the observer's hand. By this means very satisfactory results have been secured, the probable error of a single observation, including errors of star places, being $0^s.12$.

The possibility of applying similar motors to a photographic transit instrument is also being investigated, the plate being moved in such a way as to compensate as nearly as possible for the motion of the star images. (*Author's abstract.*)

Discussed by Messrs. WHITE, KRACEK, CURTIS, and LAMBERT.

R. E. GIBSON and L. H. ADAMS: *The volume change of rubber under pressure.*—Direct measurements were made of the fractional change in volume undergone by samples of rubber when subjected to pressures up to 12,000 megabaryes. The samples investigated were:—hard rubber containing 27 percent of sulphur, and two specimens of soft rubber containing 10 and 5 percent of sulphur, respectively. Between 1 and 12,000 mb. the changes in volume for the specimens in descending order of sulphur content are 13.3, 16.1 and 18.5 percent of the volume at 1 mb. respectively. The compressibilities of the samples arranged in like order fall from 19.2, 35.2 and 36.6 at 1 mb. to 6.3, 5.9 and 6.3 at 12,000 mb. The compressibilities are fractional volume changes expressed in parts per million per megabarye. The course of the compressibility curve for soft rubber is strongly suggestive of that of a liquid. (*Author's abstract.*)

Discussed by Messrs. CANFIELD, GISH, HAWKESWORTH, DRYDEN, KRACEK, L. H. ADAMS, and CURTIS.

1005TH MEETING

The 1005th meeting was held in the Cosmos Club Auditorium, March 29, 1930, President LAMBERT presiding.

Program:

C. G. MCILWRAITH: *Radio frequency standards:* Discussed by Messrs. BROWN, CRITTENDEN, HUMPHREYS and TUCKERMAN.

H. DIAMOND: *Radio aids to air navigation.*—Research work on a visual-type radio-beacon system for use on the airways of the United States has been under way at the Bureau of Standards during 1926–1929. As a result of this work a system has been developed which fulfills the requirements for course navigation on the civil airways. A directional transmitter is employed on the ground making possible the use of simple apparatus on board the air-

plane. A single receiving set is sufficient to make use of all the radio aids provided. Visual indication is provided by means of a tuned-reed course indicator. The pilot observes the vibration amplitudes of two reeds. On the course, the amplitudes are equal. Off the course, they are unequal, the reed vibrating with the greater amplitude being on the side to which the airplane has deviated.

Two types of beacon transmitters are described, the double-modulation and the triple-modulation. The former is capable of serving either two courses at 180° with each other or four courses at arbitrary angles. The latter serves twelve courses at arbitrary angles, and is better adapted for use at airports located at the junction of a large number of airways. Reed indicators for use with the double-modulation and triple-modulation beacons are described.

A discussion of the receiving set and receiving antenna system employed is included. Airplane engine ignition shielding is also discussed.

A marker-beacon system has been developed whereby the pilot is given visual indication of his exact position at definite intervals along the route.

Special adaptations of the beacon system are described for facilitating landing in fog. (*Author's abstract.*)

1006TH MEETING

The 1006th meeting was held in the Cosmos Club Auditorium, April 12, 1930, Vice President Curtis presiding.

The program consisted of five illustrated papers discussing various phases of the scientific work during the seventh cruise of the *Carnegie*. The discussion of the papers was deferred until they had all been presented.

Program: J. A. FLEMING: *Terrestrial magnetism.*—Of the 110,000 nautical miles planned for the seventh cruise of the *Carnegie*, nearly one-half had been completed since her departure from Washington, May 1, 1928, upon her arrival at Apia, November 28, 1929. The work done has realized practically in every detail the extensive scientific program planned to determine magnetic secular-variation, to extend the atmospheric-electric survey, and to undertake more comprehensive work in physical and chemical oceanography and in marine biology and meteorology. An outstanding feature had been the successful development of the practical technique and instrumental appliances for oceanographic work on a sailing vessel—an accomplishment of which Captain AULT and his men had good reason to be proud. During the first six cruises chief emphasis was placed on the magnetic and electric programs, with only a moderate amount of atmospheric-electric and meteorological observations. In Cruise VII those high standards planned under the energetic directorship of Dr. BAUER and his coworkers, and so well developed by the vessel's first commander, W. J. PETERS, and his successor, Captain J. P. AULT, were being maintained.

But Cruise VII was tragically the last of the seven great adventures represented by the world-cruises of the *Carnegie*. It was shortly after one o'clock November 29, 1929, while in harbor at Apia, Western Samoa, and completing the storage of 2,000 gallons of gasoline, that an explosion took place as the result of which Captain AULT and Cabin-Boy KOLAR succumbed, the engineer, mechanic, and three seamen were injured, and the vessel with all her equipment was destroyed by the resulting fire.

Thanks to that characteristic promptness of Captain AULT, however, all records, reports, and samples obtained to arrival at Pago Pago, American

Samoa, November 18, 1929, had been mailed or forwarded by freight from that port, and all have now been received in Washington.

The standard instruments for the program in terrestrial magnestism were the collimating-compass for declination, the deflector for horizontal intensity, and the marine earth-inductor for inclination. Mr. F. M. SOULE, one of the scientific staff on Cruise VII, had been carrying on experimental work aboard during the cruise with the inductor for the determination of horizontal intensity, and the progress made which will be described elsewhere gives promise that this method will ultimately be more reliable than the deflector method. The summary of the ship's log and magnetic observations during May 1928 to November 1929 shows that in a total of 376 days actually at sea 44,877 sea miles had been covered by the vessel, and that the magnetic declination, horizontal intensity, and inclination had been determined at 520, 175, and 174 stations, respectively. Shore observations were also obtained at repeat-stations in Iceland, Barbados, Easter Island, Peru, Western Samoa, Guam, Japan, and California, including intercomparisons of magnetic standards at the following observatories: Seddin (Germany), Huancayo (Peru), Apia (Western Samoa), and Kakooka (Japan).

The preliminary values of the magnetic elements and the average annual-changes based on over 100 intersections with previous cruises of the *Carnegie* in the Atlantic and Pacific oceans have been published. The values obtained through September 1929 have been utilized by the United States Hydrographic Office in preparing its revised isomagnetic world-charts for the epoch 1930 only recently issued. The annual-change values show that the recent isomagnetic charts are substantially correct. The agonic line, however, is nearer the western coast of South America than indicated on the charts. The area of rapid increase in magnetic inclination in the western Caribbean and off the coast of northwestern Peru extends westward to the line of no annual change passing from the Gulf of Alaska past the neighborhood of Samoa. The annual-change values of horizontal intensity are not quite so consistent as are those of other elements—a condition to be expected in view of the greater difficulty in precise determinations of this element.

In view of the fact that the Institution's magnetic-distribution survey of the oceans has been practically completed in the work already done by the *Carnegie* and because of the large sum—probably twice the original cost—which would be required to construct and equip a second and like non-magnetic ship, the trustees of the Carnegie Institution of Washington have decided not to replace the *Carnegie*. It is hoped, however, that steps may be initiated through cooperation of oceanographic interests in the United States for a ship specially designed for oceanographic researches including occasional magnetic and electric observations in all oceans in continuation and development of the plans which were being executed on the *Carnegie*. It is in this way chiefly that the experience and technique acquired in many years of preparation, of development of instruments, and of cruising could be capitalized to benefit future oceanographic research.

The high esteem and regard for Captain AULT and his work have been demonstrated by the many cablegrams, letters, and resolutions of condolence received from all parts of the world. These too have furnished much additional evidence of that universal good-will which has, throughout the cruises of the *Carnegie* and her predecessor, the *Galilee*, so marked these activities. (*Author's abstract.*)

F. N. SOULE: *Oceanography.*—The actual work of observation and collection in the field of physical oceanography on Cruise VII of the *Carnegie* consisted of the collection of bottom-samples and the measurement of depths, temperatures, and salinities. Various bottom-sampling devices were used. Depths were measured with thermometers, wire lengths, and sonic-soundings. Temperatures were measured by means of deep-sea reversing thermometers, and water-samples were collected with Nansen water-bottles. Salinities were measured by the conductivity method using the Wenner salinity-bridge. The extent of the work is described as well as the method of collection and measurement. (*Author's abstract.*)

H. W. GRAHAM: *Biology and chemistry.*—The biological program of the *Carnegie* was designed for the study of the planktonic organisms in the upper 100-meter layer in the open ocean. Silk nets were towed at the surface, at 50 meters, and at 100 meters for the capture of qualitative samples, and a Pettersson plankton-pump was operated at the same levels to obtain samples for quantitative studies.

The chemical program was confined to a study of the conditions affecting the distribution of organisms in the sea. All water-samples collected were analyzed for hydrogen-ion concentration, phosphates, silicates, and dissolved oxygen. The results in the Pacific show that the waters may be divided into three general layers: An upper layer where an active plant and animal life is maintained, a middle layer in which a decomposition of organic remains is taking place, and a lower layer which represents water that has been conducted from polar regions. The upper layer shows high values of dissolved oxygen but low values of phosphates, silicates, and hydrogen-ion concentration. The middle layer is low in oxygen but high in phosphates and silicates, and is relatively less alkaline. The lower layer tends toward conditions at the surface with again higher values of dissolved oxygen and lower of phosphates, silicates, and hydrogen-ion concentration. (*Author's abstract.*)

J. H. PAUL: *Meteorology.*—An abbreviation of the usual magnetic investigations made it possible to undertake a complete meteorological program during Cruise VII of the non-magnetic vessel *Carnegie.* In addition to the ordinary observations, a study of several special problems in atmospheric circulation over the oceans was initiated. Temperature and humidity lapse rates from quarter-deck to masthead were recorded automatically by a Hartmann and Braun electric-resistance multi-thermograph with three pairs of thermal elements (wet and dry) at various heights. Continuous thermograms of sea-surface temperature were obtained by a bulb-and-capillary recorder. Continuous humidity measurements were also obtained by a recording aspiration psychrometer of Negretti and Zambra manufacture for immediate use aboard and as a control on the multi-thermograph. These instruments were all intercompared with standard thermometers daily. A continuous record of atmospheric pressure was kept by an aneroid barograph which was daily checked by readings on standard mercurial barometers. In addition to these records, soundings of the upper air were made almost daily in the Pacific with hydrogen-inflated pilot balloons for direction and velocity of the air currents to great heights. Measurements of the rate of evaporation were carried out when conditions were favorable. Projected studies in total solar and sky radiation, although of great interest, had to be abandoned because of the difficulties encountered in working on a vessel with lofty sails and because of pressure of other work.

The great interest of meteorologists in the work of the *Carnegie* is due to the fact that she sailed in regions from which data is very scanty and was working with instruments whose accuracy is known, something one can not claim for the commercial vessels from which ocean observations are ordinarily obtained. (*Author's abstract.*)

O. H. GISH: *Atmospheric electricity.*—Work on previous cruises of the *Carnegie* has shown not only that satisfactory measurements of the elements of atmospheric electricity could be made on a moving vessel at sea but also that the electrical state of the atmosphere over ocean areas is little affected by local factors such as give a confusing complexity to these phenomena over land. It was due to this circumstance that S. J. MAUCHLY was able to conclude, from the comparatively small amount of data obtained on Cruises IV, V, and VI, that the regular change during the day of the electric intensity, or potential gradient, over the oceans proceeds on a universal schedule everywhere. This important discovery has been verified by the extensive data obtained on Cruise VII. Much encouraged by the outcome of earlier cruises a more intensive and elaborate program was planned for Cruise VII, general facilities and sundry instrumental features were improved, a photographic recorder for potential gradient was installed at Washington (May 1928) and a recorder of conductivity at San Francisco (August 1929), an additional instrument for measuring the penetrating radiation and of a different type from that used on the Carnegie since 1915 was provided. These and an Aitken "dust" counter constituted the new instrumental equipment.

As a measure of the work accomplished, the following is significant: Aside from over 200 complete daily programs and a number of diurnal-variation series (24 consecutive hours each) not completed due to the development of bad weather, the number of complete diurnal-variation series with eye-reading instruments were obtained as follows: conductivity, 22; ionic-content, 20; mobility (indirect), 20; penetrating radiation, 26; condensation nuclei (with Aitken dust counter), 15; and with photographic recorders satisfactory complete daily records of potential gradient, free from negative potential, were obtained for 194 days and of conductivity for 56 days, the latter from San Francisco to Apia. The diurnal-variation series by eye-readings were obtained at about twice the rate for previous cruises, and the recorder yielded satisfactory data at more than tenfold the rate previously attained by eye-reading methods. The gratifying success of this program is in a great measure due to the enthusiasm, diligence, and skill of W. C. PARKINSON, senior scientific officer, who was in charge of the work on board throughout the cruise, and O. W. TORRESON, executive officer, from Washington to San Francisco, and S. E. FORBUSH, executive officer, San Francisco to Apia, who assisted in some aspects of the work. (*Author's abstract.*)

The papers were discussed by Messrs. HECK, PETERS, SVERDRUP, CURTIS and HAWKESWORTH.

OSCAR S. ADAMS, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

GEORGE OTIS SMITH, Director of the Geological Survey since 1907, resigned December 22, 1930 to accept appointment as Chairman of the Federal Power Commission. WALTER C. MENDENHALL, formerly chief geologist, has been designated acting director by the Secretary of the Interior. T. W.

STANTON is now acting chief geologist; JOHN B. REESIDE, JR., is acting geologist in charge of the section of paleontology and stratigraphy; and H. D. MISER has been designated acting chairman of the committee on geologic names. Messrs. REESIDE and WILLIAM W. RUBEY have been added to the committee.

H. G. BARBER of Roselle, New Jersey, has been appointed a specialist in Hemiptera in the Bureau of Entomology and placed in charge of the collection in the National Museum.

Dr. WM. A. HOFFMAN, of the Porto Rican School of Tropical Medicine, and Dr. JOSEPH BEQUAERT, of the Harvard University Medical School, were visitors at the Division of Insects of the National Museum in December.

Dr. CARLETON R. BALL, formerly principal agronomist in charge of the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, went to California early in January to take charge of a survey of federal, State, and local (county and city) relationships in the diverse agricultural activities in that State. The survey of agriculture, which is the first of a series planned to cover these relationships in all human activities in California, is conducted by the Bureau of Public Administration of the Department of Political Science of the University of California at Berkeley with funds from the Rockefeller Foundation. It is hoped to complete and publish the agricultural survey in 1931.

Dr. DAVID G. FAIRCHILD, botanist and agricultural explorer now attached to the Office of Foreign Plant Introduction of the Department of Agriculture, has been awarded the GEORGE ROBERT WHITE medal by the Massachusetts Horticultural Society.

Obituary

GEORGE GOODING AINSLIE, of Knoxville, Tenn., since 1908 connected with the U. S. Bureau of Entomology, died suddenly in Washington December 19, 1930. He was born in Rochester, Minn., March 7, 1886. He studied at the University of Minnesota, where he was assistant to the State Entomologist from 1906 to 1908. During 1909–1910 he was assistant in entomology at Clemson College.

FREDERICK J. PRITCHARD, plant physiologist of the Bureau of Plant Industry since 1910 and a member of the Academy, died suddenly at his office January 13, 1931. He was born at Camanche, Iowa, December 24, 1874. He received the degree of bachelor of science from the University of Nebraska in 1904 and later served as instructor in botany and bacteriology at the North Dakota Agricultural College, where he became assistant professor in botany and pathologist at the college experimental station in 1905. In 1907 he was made assistant in plant breeding at Cornell University and in 1909 became botanist at the Wisconsin Experimental Station while an agent of the Department of Agriculture. He specialized in breeding disease-resisting varieties of tomatoes.